



U.S. Army Research, Development and Engineering Command



***TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.***

## **Systems Thinking in the Army**

**Presented by: MG. Nick Justice**  
**Commanding General RDECOM**

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# Why do Systems Thinking?



# Systems Thinking: Outside the Box

Desired Capability: Space exploration will require a writing implement that is capable of writing in:

1. A vacuum
2. Zero g environments
3. Planar orientations (from 0-360)°
4. Hot temperatures of +150°C in sunlight
5. The cold shadows of space at -120°C



2 Years, and a total investment of \$1M

**Fisher  
Corporation  
Interpretation**



0 years, and a total investment of ¢0.3

**Alternative  
Interpretation**

**Be careful how you define the problem**

# Systems Thinking: Outside the Box

## Army EOD Robot Example

- Background: Interrogating IED takes a lot of time
  - Route Clearance Patrols are exposed to unnecessary danger when deploying EOD robots
  - The EOD technician has to dismount the truck, take out the robot, to properly configure the robot for it's mission, all the while exposed to potential small arms fire
- ***Desired Capability:*** Provide the Route Clearance Patrol Engineers and EOD technicians a way to transport and deploy a Talon robot, and/or Packbot, with a camera and robot arm, without exposing the crew to danger

**Be careful how you define the problem**

# Systems Thinking: Army EOD Robot Example



**Overcomplicating the problem**

# Systems Thinking: Outside the Box

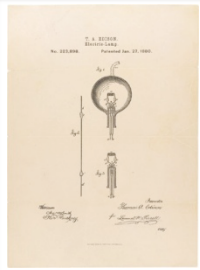


**The Simple Solution**

# Systems Thinking: Awareness of Multiple Solutions

## Setting the Stage: 1920

1880 - Electric Light  
Bulb Patented



1880

1905 – 1910 Electricity Available  
in Larger Metropolitan Cities



1901- Marconi demonstrates  
Wireless Radio Telegraph



1920 – 1925 Radio  
Enters the Home



1923 – 1925 Electrical Vacuum Tube  
microphone results in more music  
available on Record



1925 – “Talkies”  
Black and White  
Movies with Sound  
become available

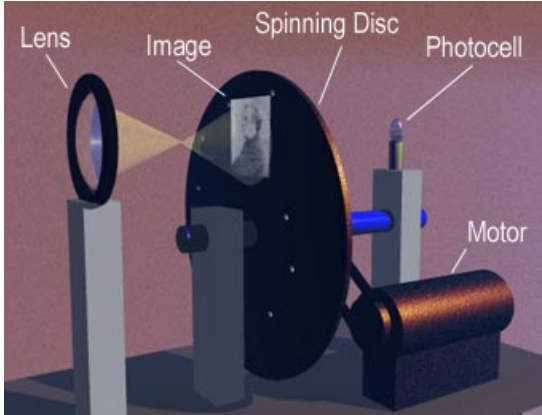


1925

**Desired Capability: Provide an in-home entertainment  
experience which provides moving pictures and sound**

# System Thinking

## Mechanical Television



- Evolutionary Idea
  - Uses Rotating disk to create 'moving' images
- Stemmed from the Moving Picture

### Brute Force Solution

- Issues with Camera and TV scaling
- Performance limitation (lines and images per second)
- Synchronizing motor speeds

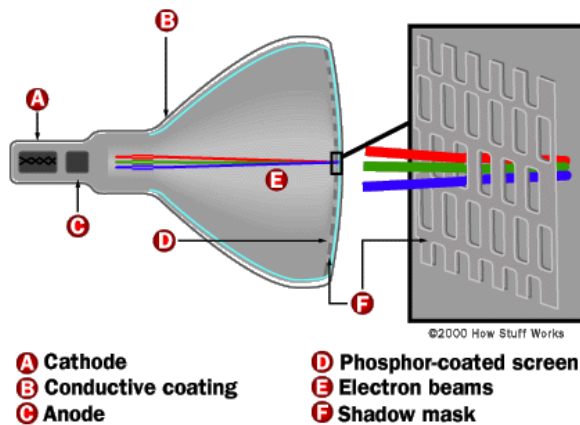


**1926, In the U.K. John Logie Baird**  
Develops a Mechanical Television

**Be aware that there are multiple competencies  
(illities & engineering disciplines) to solve a problem**

# System Thinking

## Electrical Television



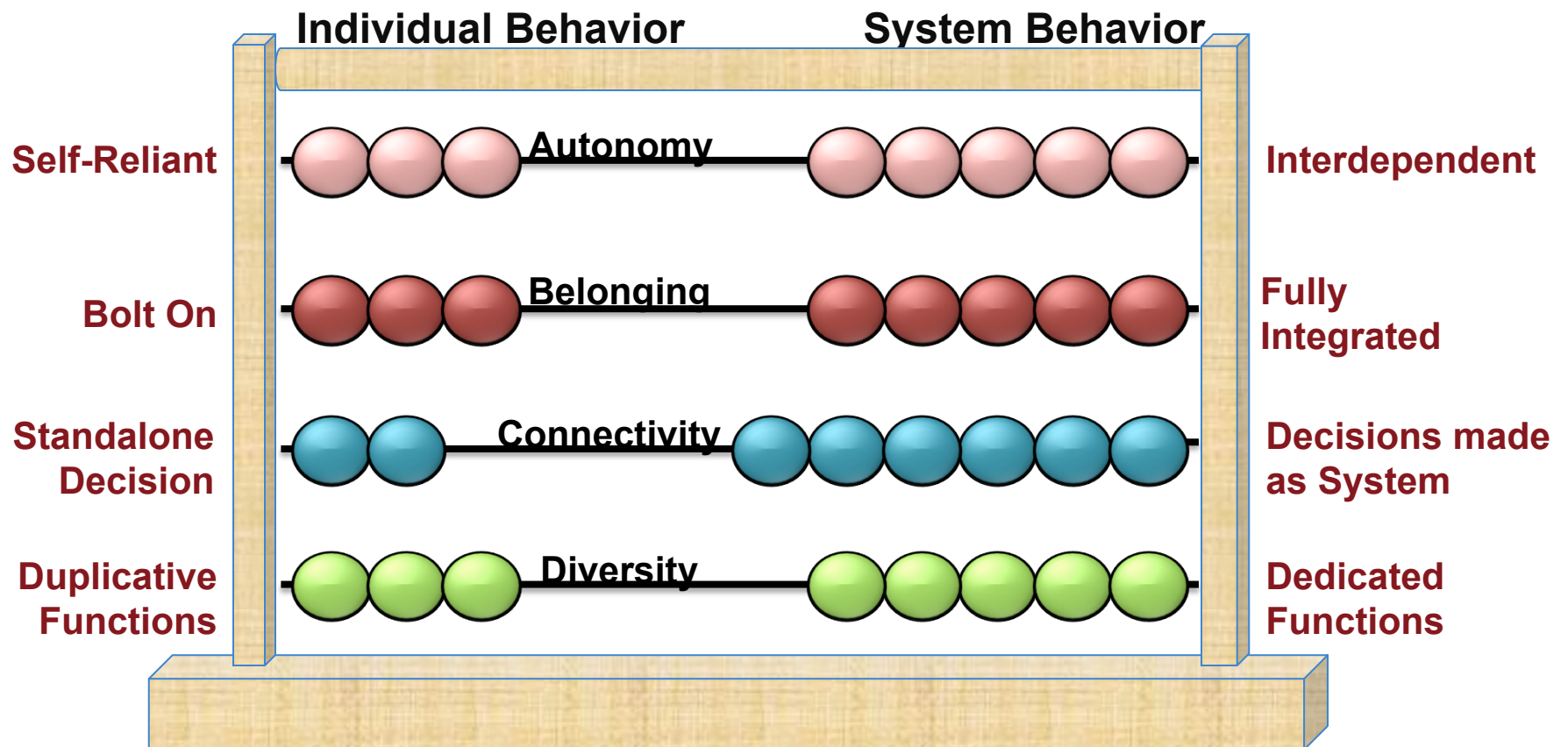
- **Revolutionary Idea**
  - Uses pixels to form an image
- **Complex Approach resulting in a simpler overall system**
- **Stemmed from the invention of the Cathode Ray Tube**
  - Uses an electron gun directed by an electromagnet to fluoresce a screen



**Be aware that there are multiple competencies (sciences & engineering disciplines) to solve a problem**

# Systems Theory

## The test for “Systems”



A systems must demonstrate some new and Emergent behavior or function

Tenets for Systems Established by Georg Wilhelm Friedrich Hegel  
Circa 1820

# Systems Theory

## U.S. Army System Example



The U.S. Army:

- Every component has to give up some **Autonomy**
  - Comport with the Military Code of Conduct, i.e. behavior, hair cut, uniform, etc.
  - **Overall Systems becomes more Autonomous** – e.g. Deploy on 4 hours notice
- To **Belong** each component must centralize some functionality
  - **Become a Part of the Team**,
- Each component must be **Diverse** (add a non-redundant function to overall system)
  - **Specific** jobs and specialties
- Components must be **Connected** and share resource with overall systems
  - **Trust and Reliance** on fellow soldiers and the Army – e.g. meals, overwatch



Greater than the sum of its elements

# HMMWV Example

## Non-Systems Behavior

### Redundant Component function- e.g.

- Timing sources
- Displays screens
- Operating Systems
- Controls (HW/SW)
- Cooling (heat sink and fans)
- Power conversion (DC to DC/AC)
- Power Conditioning & Surge protection



**Limited sharing and Trust** - Information from one system doesn't cue or drive the behavior in surrounding systems

# The Price for Non-Systems Behavior

- Every component holds on to their **Autonomy**

## Incompatible Goals

- Each component has **decentralized** functions

## Bolt On Behavior

- Each component has **unintended redundant** function

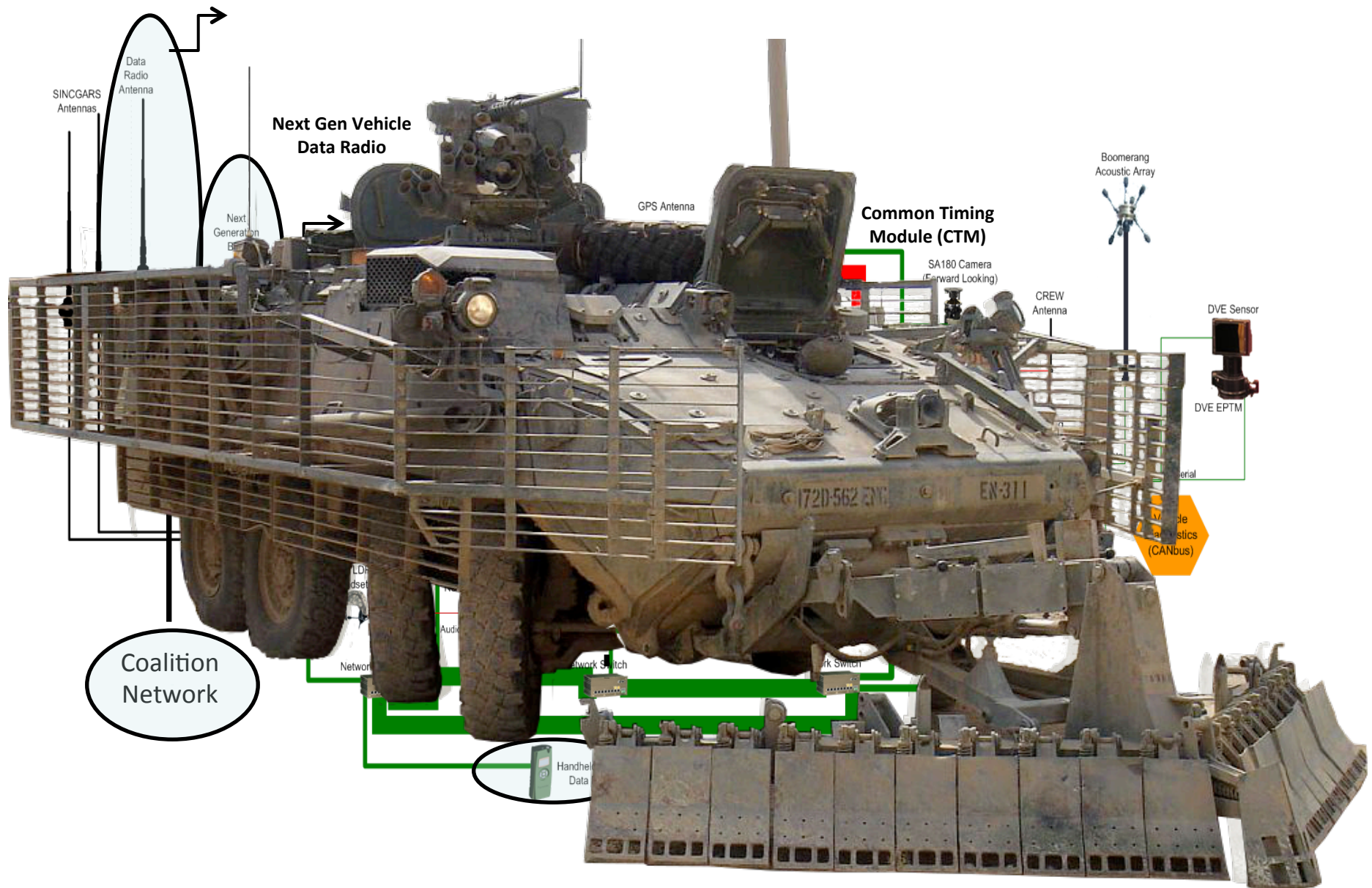
## Duplicative Functions

- **Non System-Centric** Decisions making

## Decisions in a vacuum



# VICTORY Next Generation Enhancements



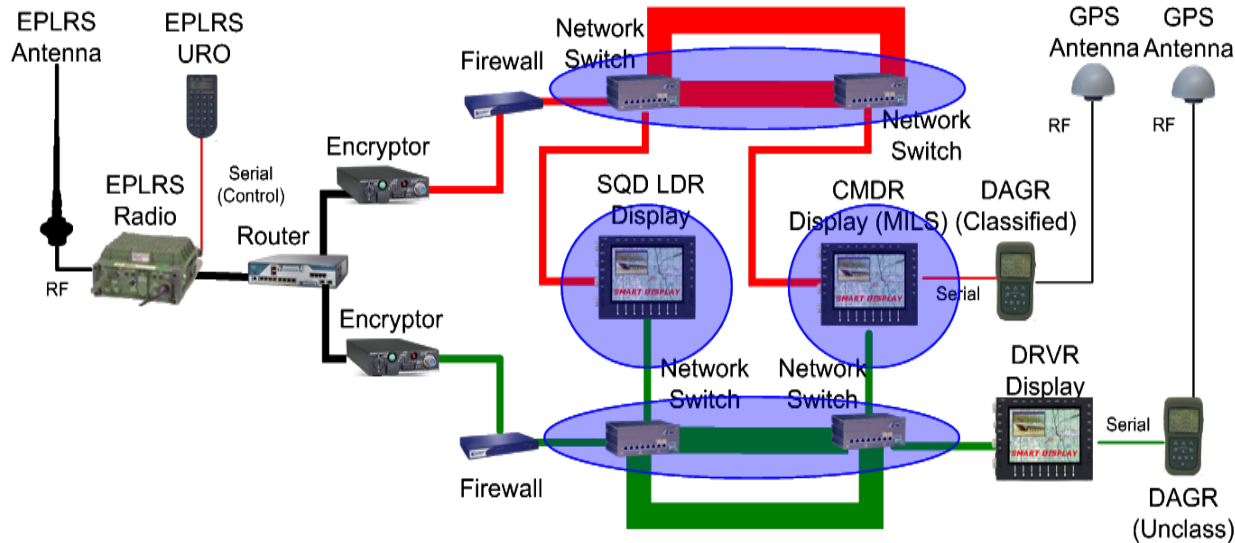
So why use SF?



described

Backup

# Information Assurance [Multiple Independent Levels of Security (MILS)]

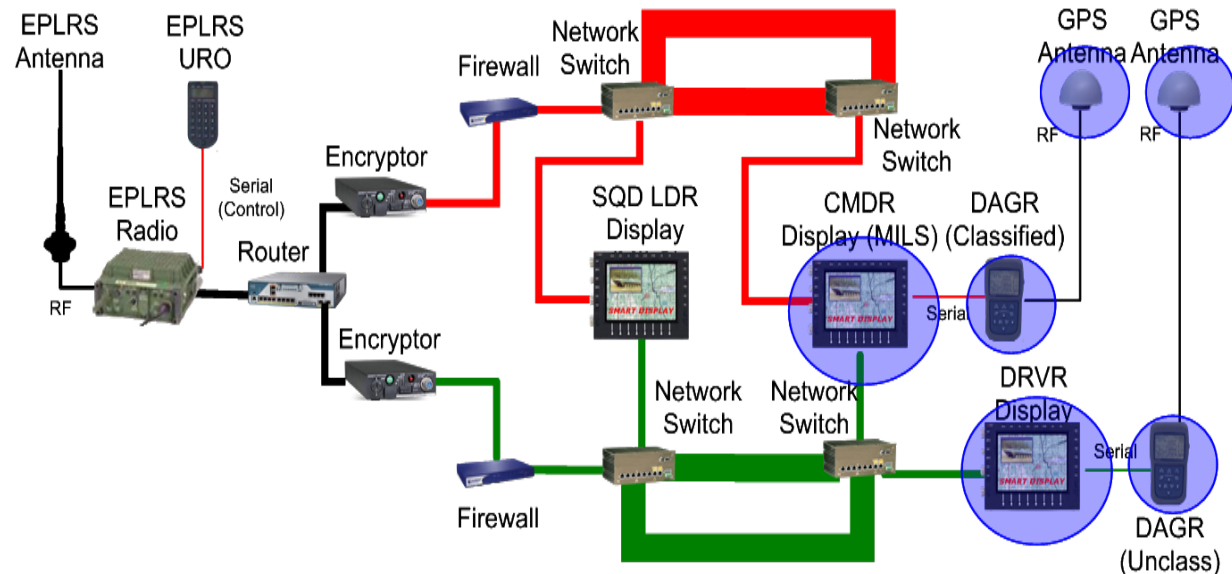


## MILS solution protects data in intra-vehicle network

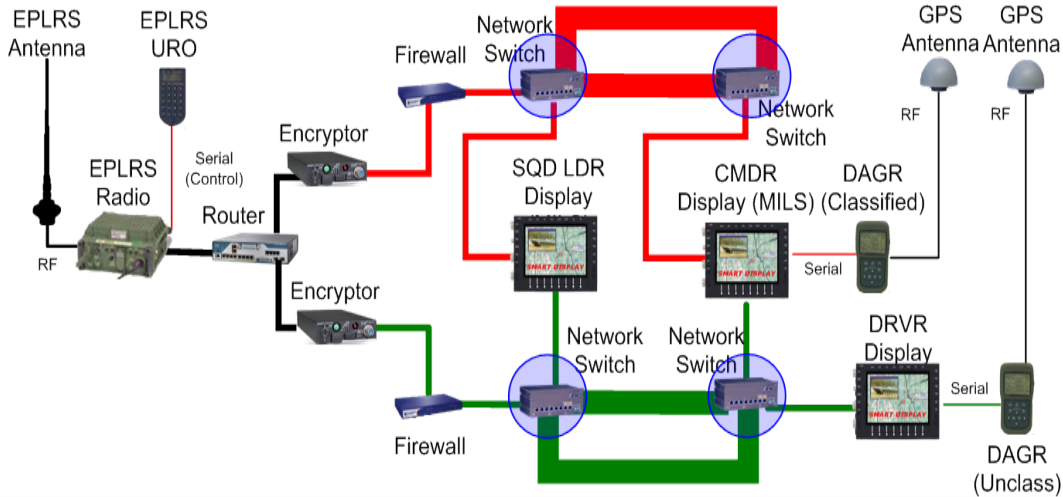
- Two physically separated enclaves (secret and unclassified)
- UNCLASS apps and users (e.g. CLOE) are accommodated
- Shared smart display with trusted separation kernel
- Accepts processing assets that include their own cross domain guards

## Time & Location Distribution

- GPS antenna and receiver for each classification level
- Time & location are published on the network
- Allows for fewer GPS devices to support C4ISR/EW systems



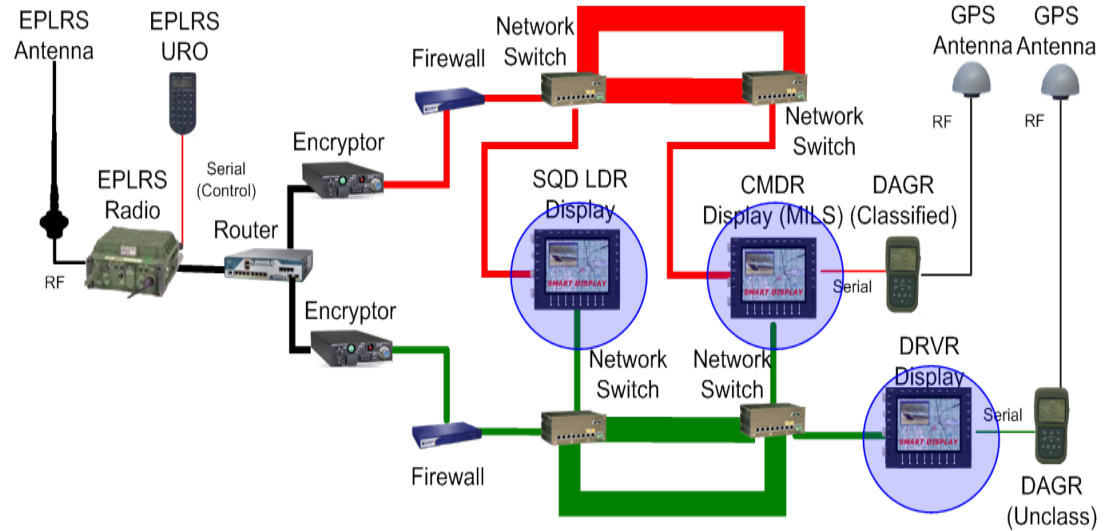
# Ethernet Data Bus Platform Network



- Gigabit Ethernet Switches with copper media
- High bandwidth connections within the vehicle

## Shared Smart Displays

- Displays w/custom presentation of information
- Touch screens for user input (WMI)
- Processing and data storage capability



# October 2009 Stryker Validation Design

## Consolidated Physical View

